An Assessment of Soil Erosion Impacts on Lakeside Property Values in Ohio: A Hedonic Pricing Method (HPM) Application

ESO 2275

by

Somskaow Bejranonda and Fred J. Hitzhusen*

*Graduate Associate and Professor, respectively, The Department of Agricultural Economics, The Ohio State University, Columbus, Ohio 43210 November 1995

Abstract

A hedonic pricing model is developed for estimating the effects of structural, community and environmental (sedimentation) factors on lakeside property values at 15 Ohio state park lakes. A demand system is developed and upstream soil conservation practices and dredging activity are simulated to measure the economic welfare changes.

Problem and Objectives

Sedimentation caused by soil erosion is a major source of damages and losses to reservoirs and lakes in Ohio. Most of these sediment come from agricultural activities which comprise 77 percent of the 15 4 million acres of cropland. Several studies have been done in Ohio to estimate the annual agriculturally related off-site soil erosion. In 1983, the Soil and Water Division of the Ohio Department of Natural Resources (ODNR) estimated the off-site sediment costs of soil erosion in Ohio at $160 million/year. The Ohio Alliance for the Environment (1988) estimated the annual cost of removing sediment from Ohio's lakes, waterways, harbors, and water treatment plants at $162 million.

Research done by Macgregor (1988) found that sedimentation in the 46 state park lakes causes boater value losses to non-residents visiting the lakes. His study indicated that the average boater value loss in 46 state park lakes was $0.49 per ton of sediment and the value ranged from less than $0.01 to $11.95 per ton of sediment. However, his research did not capture the impact of sediment on the lakeside resident property values. Residents who live adjacent to the lakes will be directly affected by the impact of sediment. These property owners will be heavily impacted if the lakes cannot be used for boating, fishing, swimming, and any other activities due to shallow depths and change in water quality caused by sediment in the lakes Some lakeside property owners lose their scenic view due to increasing weeds and algae. These impacts lead to a decline in property and recreational values.

In Ohio, the Division of Watercraft of the Ohio Department of Natural Resources allocates one-seventh (almost $2 million annually) of the total budget of the Waterways Safety Fund for purpose of dredging the lakes. These costs of dredging have been borne by boaters in terms of boater registration fees that they pay every three years (depending on factors such as size and power of the boat) and tax for marine gasoline (a one-half of one percent tax on gasoline used by boaters goes to the Waterways Safety Fund), even though boaters may not be the primary beneficiaries of dredging and are not the creators of sediment. Upstream farms are the major sources of sediment run-off but these farmers only pay for dredging (if they boat) and do not make any direct compensation to the downstream users. The question of who should be responsible for remediation of the soil erosion impacts that damage the downstream users continues to be debated.

A report done by the Soil Conservation Service (1990) suggests that there are two methods to reduce the amount of sediment accumulation in the lakes. The first method is dredging the lake to remove the accumulated sediment directly. The second procedure is to control upstream soil erosion by employing soil conservation practices.

The major objective of this study is to measure the off-site impacts of sediment on lakeside residents and estimate the benefits of dredging and upstream soil conservation practices. The benefits obtained from a dredging program reduce the amount of sediment accumulated in the lakes, thus increasing the average depth of the lakes. Alternatively, changing the upstream soil conservation practices from conventional to reduced till and no-till systems (which assume that sediment inflow is reduced by 50 and 75 percent, respectively) reduces the sediment entering the lakes.

The following sections discuss the Hedonic Pricing Method which is a modeling strategy that describes the lakeside residents' choices among lakeside properties where prices depend on many factors (such as structural, community, and surrounding environmental characteristics) and the Linear Approximate/ Almost Ideal Demand System (LA/AIDS) which is used to estimate the demands for structural and environmental characteristics of lakeside properties. Finally, the compensating variation (CV) derived from the indirect utility function of LA/AIDS is used to estimate the lakeside residents' willingness to pay for improvements in the environmental characteristics at the lakes (such as increasing the average depth of the lakes through dredging program and reducing the rate of sediment inflow entering the lakes by employing upstream soil conservation practices).

Study Methods

Several criteria are used to select the Ohio state park lakes for this study. First, the lakes must have a minimum of 100 water surface acres to attract settlement of private residents with properties located within 4,000 foot proximity of the lake perimeter. Second, the lakes are located in the areas which have different levels and sources of soil erosion. Lastly, the lakes have different horse-power (HP) regulations. A total of 15 state park lakes are chosen based on these criteria and are categorized into two groups based on horse-power regulation. The eight lakes that have HP greater than 10 include Buckeye Lake, Caesar Creek, Grand Lake St. Marys, Indian Lake, Rocky Fork, Lake White, Mosquito Lake, and Lake Loramie. The second group of lakes which have HP equal to or lower than 10 are Harrison Lake, Madison Lake, Lake Logan, Kiser Lake, Guilford Lake, Wolf Run, and Jackson Lake. The 15 state parks lakes are divided into two groups (or markets) because this research hypothesizes that lakeside property rents between these two markets are different depending on many factors such as property characteristics themselves and activities participating at the lakes. For example, people who would like to water-ski will reside at the lakes that have HP>10, while those who enjoy sailing or fishing will be more likely to live at the lakes that do not allow higher HP.

The data used in the Hedonic Pricing Model as independent variables include; structural characteristics of the property (i.e. lot size in sq.ft. (LOT), the size of the house in sq.ft. (DWELL), the number of rooms (RM), the number of full-baths (FB), the number of half-baths (HB), the age of the building in years (OLD), the existence of air-conditioning (AC), heat (H), basement (BS), garage (GAR), fireplace (FP), and improvements of the house such as patio and deck (IMP), and the nearest distance between property and the lake in feet (DSTL)); the community characteristics where properties and lakes are located (i.e. number of population in the community (POP), the distance from property to the nearest central business district in miles (CBD), and the unemployment rate in the county (UNEMP)); and environmental characteristics of the lakes (i.e. the average depth of the lakes in feet (ADEP), the net annual sediment accumulation as a percent of the lake volume or sediment inflow (STPS), and average annual sediment dredged (DRED)). The dependent variable is the property rent which is the annual value or earning stream of the property

In the Hedonic Pricing Method (HPM), the implicit prices of property characteristics are embedded in the property rent because these prices are not explicitly offered in the marketplace. This research theorizes that property rent should be a function of the structural, community, and environmental characteristics of the properties. The model used in this research is:

$$\begin{aligned} \ln RENT = {} & a_0 + a_1 \ln LOT + a_2 DWELL + a_3 DWELLSQ + a_4 OLD + a_5 RM + a_6 FB + a_7 HB + a_8 AC \\ & + a_9 H + a_{10} GAR + a_{11} BS + a_{12} IMP + a_{13} FP + a_{14} \ln DSTL + a_{15} POP + a_{16} CBD \\ & + a_{17} UNEMP + a_{18} ADEP + a_{19} ADEPSQ + a_{20} \ln STPS + a_{21} \ln DRED \qquad (1) \end{aligned}$$

where a_i's are regression coefficients. This equation is estimated separately for each market (i.e. the limited ($HP \leq 10$) and unlimited HP ($HP > 10$) markets). This research uses multiple regression analysis to estimate the coefficients of equations. Equation (1) is expected to show the coefficients of ADEP and ADEPSQ are positive and negative, respectively, i.e. the deeper the lakes at decreasing rate, the higher the property rent. While the coefficients of STPS are expected to be negative which means the higher the rate of sediment inflow entering the lakes, the lower the property rent. The coefficients of DRED are expected to have positive impacts on property rent. That is the greater the annual sediment dredged from the lakes, the higher the property rent.

The coefficients (a_i's) derived from equation (1) are used to calculate the marginal implicit prices for each horse-power market (i.e. take derivative of equation (1) with respect to particular characteristic) and they are also used to estimate the demands for property characteristics. The welfare measurement in terms of compensating variation (CV) is calculated to evaluate the lakeside property owners' willingness to pay for obtaining the better environmental characteristics at the lakes (in terms of increasing average depth of the lakes and/or decreasing the sediment inflow entering the lakes). The formula of CV developed from LaFrance (1991) is:

$$CV = X_H^0 - \exp\left(\left(\frac{PADEP^1}{PADEP^0}\right)^{\beta_{ADEP}} (\log X_H^0 - \log P^{*0}) + \log P^{*1}\right) \tag{2}$$

where $PADEP^0$ and $PADEP^1$ are the marginal implicit price of average depth characteristic at the original level and after changing the average depth by dredging projects at the lakes, X_H^0 is the adjusted total expenditure that property owner spend on lakeside property, and log P^* is the Stone's Price Index.

In this research, the average depth of the lakes is changed by 0.5, 1.5, and 2.0 feet, respectively to evaluate the welfare change to lakeside residents if a dredging project removes sediment. These numbers are chosen because the officials at the ODNR suggest that dredging the lakes more than 3 feet at many locations cuts into the original base of the lakes. Therefore the maximum level for measuring benefits to lakeside residents from changes in ADEP is 2 feet. This research also estimates the benefits to downstream lakeside residents when the soil conservation practices are employed by assuming that under a corn-soybean-wheat rotation, changing from a conventional to reduced-till and no-till systems will reduce the rate of sediment inflow by 50 and 75 percent, respectively. The formula in equation (2) is also applied for this estimation.

Results

By testing the market segmentation based on horse-power regulation; which is an exogenous factor and used as a criterion for identifying the market in this research; the result confirms that the 15 state park lakes can be categorized into two markets which are the limited ($HP \leq 10$) and unlimited ($HP > 10$) HP markets. From Table 1, the limited and unlimited HP markets have Adjusted-R^2's of 0.7704 and 0.6910, respectively. Most of variables in both markets are statistically significant and have expected signs as hypothesized, especially the environmental characteristics. The results indicate that the deeper the lake, the less sediment entering the lakes, and the higher amount of sediment annually dredged from the lakes, the higher the property rent. By comparing the marginal implicit price at the global mean (calculated at the mean of entire data set for each characteristic), the results in Table 2 show that environmental characteristics will have more impacts on the limited HP than the unlimited HP market. This is because the lakes within the limited HP market are located in the areas that have higher rates of sediment inflow than lakes within the unlimited HP market. Also the amount of sediment dredged as a percent of lake volume within the limited HP market is higher than in the unlimited HP market. In both markets, coefficients of the average depth variable confirm that increasing the average depth of the lakes by some level increases the property rent at a decreasing rate.

The results from using the LA/AIDS to estimate the demands for structural and environmental characteristics of properties show that environmental characteristics which are the average depth of the lakes, the rate of sediment inflow, and the amount of sediment dredged are substitutes for one another. This means if the price of obtaining the deeper lake through dredging project is too high, lakeside residents may substitute by increasing in the demand for upstream soil conservation practices to reduce the rate of sediment entering the lakes. The environmental quality (i.e. reversion of the rate of sediment inflow) and amount of sediment annually dredged are the necessity characteristics for the lakeside residents whereas the average depth of the lakes is a luxury characteristic for them. Therefore, if lakeside residents' income increases, they will be relatively more concerned with average depth of the lakes. It is also likely that the environmental quality in terms of less sediment entering the lakes and amount of sediment dredged are more difficult to perceive by lakeside residents, compared to the average depth of the lakes that they can experience by themselves through some recreational activities (such as swimming and boating).

The compensating variation (CV) which is the lakeside residents' willingness to pay for obtaining the improvement in environmental characteristics at the lakes is calculated by using the formula from equation (2) The results from Table 3 show that lakeside residents at the limited HP lakes (HP$\leq$10) have higher willingness to pay per one acre-feet of sediment removed and reduction in the rate of sediment inflow into the lakes than ones who live at the unlimited HP lakes (HP>10) This is because most of the limited HP lakes such as Lake Logan, Kiser Lake, Guilford Lake, and Wolf Run have not ever been previously dredged, thus lakeside residents are willing to pay more per one acre-feet of sediment removed to obtain improvement in environmental characteristics at these lakes However, lakeside residents have higher willingness to pay per one acre-feet of sediment removed by reducing the rate of sediment inflow through upstream soil conservation practices than by increasing in average depth of the lakes through dredging By combining dredging and upstream soil conservation practices, the results indicate that benefits that lakeside residents receive are higher than employing only the dredging project and also higher under the limited HP lakes than the unlimited HP lakes. The lakeside residents' marginal willingness to pay for one acre-feet of sediment removed under dredging and soil conservation combination is also decreasing, while the marginal willingness to pay of lakeside residents under dredging and/or upstream soil conservation practices is increasing at a decreasing rate.

Tables 4 and 5 show the benefits received by lakeside residents at each lake location under dredging and/or upstream soil conservation practices Among the limited HP lakes, lakeside residents at Madison lake will gain the highest benefits on property rent if dredging and the combination procedure are implemented Alternatively, lakeside residents at Wolf Run will gain more benefits in terms of increases in property rent if upstream conservation practices implement. Among the unlimited HP lakes, lakeside residents at Lake White will gain more on property rent under dredging and the combination project. Whereas lakeside residents at Lake Loramie will gain more if upstream soil conservation practices are employed.

ODNR has annually dredged and currently dredges at Buckeye Lake, Indian Lake, Lake Loramie, Grand Lake St.Marys, and Rocky Fork even though the benefits received by lakeside residents at these locations are less than ones in the limited HP lakes. This result can be explained by a study done by Lehman et.al (1995), which shows that the existence of a lake association is an important factor in getting dredging funds from ODNR through lobbying their Ohio House representative A larger lake such as Indian Lake has politically active lobby groups and they have been successful in obtaining dredging funds. One might argue that lakeside residents who gain benefits from dredging should bear some of the costs of dredging in terms of paying higher property taxes or levies. Results from this study also show that implementing upstream soil conservation practices can generate relatively more benefits to downstream lakeside residents in terms of property rent than dredging.

Summary and Conclusion

The main objective of this study is to estimate the economic impact of sedimentation on lakeside residential property values in Ohio state park lakes and provide some economic evidence for an optimal combination of changing upstream soil conservation practices and downstream dredging project to reduce the sedimentation problem.

Hedonic Pricing Method was developed to estimate the impacts of sedimentation on lakeside property values. The important environmental factors that affect the property values (in terms of annual rent) are the average depth of the lakes, the rate of sediment entering the lakes as a percent of lake volume, and the amount of sediment annually dredged.

There are four main conclusions that can be drawn from this empirical study. First, environmental characteristics of the lakes which are the average depth of the lakes and the amount of sediment annually dredged have positive impacts on lakeside property rent. The deeper the lake at a decreasing rate and the larger the amount of sediment dredged, the higher the lakeside property rent. Whereas the rate of sediment inflow entering the lakes has a negative influence on lakeside property rent which means the higher the rate of sediment inflow into the lakes, the lower the property rent. Second, the environmental characteristics are substitutes for one another. Third, lakeside residents at the limited HP lakes (Harrison Lake, Guilford Lake, Jackson Lake, Kiser Lake, Logan Lake, Madison Lake, and Wolf Run) have more economic gains from improvements in the average depth of the lakes and reductions in the rate of sediment entering the lakes if a dredging project and/or upstream soil erosion control are proposed than ones in the unlimited HP lakes (Buckeye Lake, Caesar Creek, Grand Lake St.Marys, Indian Lake, Lake Loramie, Lake White, Mosquito Lake, and Rocky Fork).

The foregoing suggests that implementing the upstream soil conservation practices will provide more economic benefits to downstream lakeside residents in terms of increasing property rent than increasing average depth of the lakes through dredging. Therefore, targeting soil erosion control based on off-site damages to downstream lakeside property values will give more benefits to society. Taxes or penalties rather than subsidies can be used as a mechanism of the public policy to optimize net social economic benefits. For example, society might decide to impose penalties based on downstream damage of soil erosion from upstream soil loss above T-level and subsidize if there is any reduction in upstream soil loss below T-level.

This study focuses only on a single category of off-site economic impacts from sedimentation--lakeside residential property values. Therefore, the other off-site damages on downstream lakeside residents (such as boater value loss), municipal, and industrial users (such as flood control and water treatment cost) should be incorporated to optimize the social net benefits from soil conservation.

Table 1: Summary Descriptive Statistics of Variables Used in Hedonic Model and Coefficients Estimated for the Limited HP (HP≤10) and Unlimited HP (HP>10) Markets

Variable	Limited HP Market (HP≤10)				Unlimited HP Market (HP>10)			
	Mean	Standard Deviation	Coefficient Estimated	t-value	Mean	Standard Deviation	Coefficient Estimated	t-value
Dependent Variable								
RENT	4480.74	2936.28			6630.94	4610.65		
Independent Variables								
INTERCEPT			0.5412	0.718			7.7607***	53.264
LOT	28939	55418.07	0.2087***	5.587	15327.35	31646.41	0.0756***	6.310
DWELL	930.43	405.74	0.0022***	8.099	1188.85	532.59	0.0008***	14.567
DWELLSQ			-0.00000031***	-5.684			-0.00000009***	-4.65
OLD	32.28	19.57	-0.0028*	-1.868	35.85	24.17	-0 0042***	-12.407
RM	4.58	1.51	0.0604***	3.071	5.09	1.49	0.0526***	7.700
FB	0.92	0.43	0.0368	0.536	1.15	0.49	0.0982***	5.109
HB	0.39	0.48	-0.0522	-0.667	0.31	0.51	0.0003	0.017
AC	0.13	0.34	0.0328	0.401	0.21	0.41	0.1212***	5.936
H	0.83	0.37	0.0579	0.856	0.83	0.37	0.1717***	8.318
GAR	0.36	0.48	0.0026	0.050	0.46	0.50	0.1736***	10.691
BS	0.49	0.50	0.3417***	6.267	0.44	0.50	0.0427***	2.543
IMP	0.76	0.43	0.2140***	3.659	0.65	0.48	0.0880***	4.863
FP	0.37	0.48	0.0665	1.262	0.35	0.48	0.1377***	8.182
DSTL	563.12	707.76	-0.0909***	-4.781	552.22	723.04	-0.1838***	-26.006
POP	5017.46	3176.01	0.0003***	9.004	5914.86	3686.88	0.0000057**	1.984
CBD	8.48	6.60	0.1121	0.778	9.20	4.53	-0.0190	-0.814
UNEMP	7.84	1.74	-0.0211	-0.580	6.72	1.41	-0.0373***	-5.397
ADEP	7.93	5.30	0.0875***	6.432	6.35	5.53	0.0238***	4.693
ADEPSQ			-0.0007*	-1.775			-0.0001***	-5.194
STPS	0.28	0.28	-0.1545***	-3.067	0.13	0.20	-0.1104***	-9.812
DRED	44.30	72.50	0.1812***	5.568	7.52	9.06	0.1085***	10.076
	R^2=0.7831 F-statistic=61.5424		Adj-R^2=0.7704 N=380		R^2=0.6938 F-statistic=245.440		Adj-R^2=0.6910 N=2297	

* denotes the significant level at 0.10 percent for t-test
** denotes the significant level at 0.05 percent for t-test
*** denotes the significant level at 0.01 percent for t-test

Table 2: Implicit Marginal Price of Characteristic

Variable	I. Implicit Marginal Price Calculated at Market Mean		II. Implicit Marginal Price Calculated at Global Sample Mean	
	Limited HP (HP≤10)	Unlimited HP (HP>10)	Limited HP (HP≤10)	Unlimited HP (HP>10)
LOT	0.03	0.03	0.07	0.03
DWELL	7.27	3.89	8.45	4 70
OLD	-12.55	-27.85	-15.92	-33.28
RM	270.64	348.79	343.34	416.74
FB	164.89	651.16	209.19	778 01
HB	-233.89	1.99	-296.73	2.38
AC	146.97	803.67	186.45	960.24
H	259.43	1138.53	329.13	1360.34
GAR	11.65	1151.13	14.78	1375.39
BS	1531.07	283.14	1942.40	338.30
IMP	958.88	583.52	1216.49	697.20
FP	297.97	913.08	378.02	1090.97
DSTL	-0.72	-2.21	-0.93	-2 63
POP	1.34	0.04	1.71	0.05
CBD	502.29	-125.99	637.23	-150.53
UNEMP	-94.54	-247.33	-119.94	-295.52
ADEP	342.32	149.40	445.11	178.15
STPS	-2472.41	-5631.20	-5855.05	-5831.16
DRED	18.33	95.67	80.85	67.47

Table 3: Average Benefit Estimates from Changing the Average Depth of the Lakes and the Rate of Sediment Inflow in the Limited and Unlimited HP Market Lakes Per One Acre-Feet of Sediment Removed

Increasing ADEP (feet)	Percentage Change in STPS	Welfare Measure ($) / Acre-Feet of Sediment Removed	
		Limited HP Market	Unlimited HP Market
0.5		5.1865	0.1529
1.5		5.1887	0.1532
2.0		5.1839	0.1532
	50%	85.1197	23.2166
	75%	115.9008	31.6747
0.5	50%	6.7645	0.3296
1.5	50%	5.6025	0.2106
2.0	50%	5.4454	0.1956
0.5	75%	8.7071	0.5413
1.5	75%	6.3440	0.2854
2.0	75%	6.0322	0.2531

Table 4: Benefits Per Acre-Feet of Sediment Removed by Changing Average Depth of the Lake and Reducing the Rate of Sediment Inflow in the Limited and Unlimited HP Markets

Lake	Benefit ($) / Acre-Feet of Sediment Removed				
	Increasing ADEP (Ft.)			% Change in STPS	
	0.5	1.5	2.0	50%	75%
Guilford L.	3.7008	3.6929	3.6848	125.5111	171.1935
Harrison L.	9.8501	9.9348	9.9644	96.2951	132.1008
Jackson L.	0.5435	0.5346	0.5297	6.2530	8.5645
Kiser L.	5.0200	5.0442	5 0501	206.5446	281.6765
Logan L.	5.5172	5.5303	5.5309	97.1821	132.2841
Madison L.	14.2017	14.3311	14.3785	96.7835	131.8663
Wolf Run	2.7362	2.5217	2.4132	319.9989	434.9351
Limited HP	5.1856	5.1887	5.1839	85.1197	115.9008
Buckeye L.	0.2461	0.2394	0 2394	5.9322	8.6867
Caesar Cr.	0.1008	0.0987	0.0977	8.5148	11.6159
Grand L.St.	0.0510	0.0511	0.0512	11.7051	16.2407
Indian L.	0.1732	0.1737	0.1740	22.2746	31.0991
L.Loramie	0.5365	0.5377	0.5382	220.2547	308.4172
L.White	1.6340	1.6364	1.6373	110.7026	168.6167
Mosquito L.	0.0821	0.0817	0.0815	26.1506	38.0214
Rocky Fork	0.2019	0.2008	0.2002	39.6751	49.8141
Unlimited HP	0.1529	0.1532	0.1532	23.2166	31.6747

Table 5: Benefits per Acre-Feet of Sediment Removed by Combining Changes in Average Depth of the Lake and Reducing the Rate of Sediment Inflow in the Limited and Unlimited HP Markets

Lake	Benefit ($) / Acre-Feet of Sediment Removed					
	Rate of Sediment Inflow Reduced by 50% and Increasing ADEP (Ft.)			Rate of Sediment Inflow Reduced by 75% and Increasing ADEP (Ft.)		
	0.5	1.5	2.0	0.5	1.5	2.0
Guilford L.	4.5173	3.8813	3.7913	5.5703	4.2842	4.1124
Harrison L.	10.8724	9.9434	9.8321	12.6649	10.6753	10.4302
Jackson L.	0.6716	0.5721	0.5555	0.8304	0.6344	0.6053
Kiser L.	5.9934	5.2698	5.1779	7.2549	5.7601	5.5717
Logan L.	7.1856	5.9613	5.7997	9.2500	6.7512	6.4261
Madison L.	16.7263	14.7369	14.4934	20.4522	16.2523	15.7192
Wolf Run	8.4652	4.4054	3.8095	14.4935	6.5131	5.4114
Limited HP	6.7645	5.6025	5.4454	8.7071	6.3440	6.0322
Buckeye L.	0.2487	0.2368	0.2354	0.2730	0.2465	0.2432
Caesar Cr.	0.2006	0.1301	0.1204	0.3094	0.1679	0.1492
Grand L.St.	0.0597	0.0534	0.0526	0.0707	0.0575	0.0558
Indian L.	0.1963	0.1754	0.1728	0.2332	0.1891	0.1837
L.Loramie	2.7376	1.2899	1.1079	4.4698	1.9057	1.5823
L.White	8.4366	4.0247	3.4457	16.0764	6.9101	5.6806
Mosquito L.	0.1196	0.0936	0.0902	0.1606	0.1081	0.1014
Rocky Fork	0.5969	0.3318	0.2978	1.0271	0.4831	0.4138
Unlimited HP	0.3296	0.2106	0.1956	0.5413	0.2854	0.2531

References

Hitzhusen, Fred J. 1991. "The Economics of Sustainable Agriculture: Adding a Downstream Perspective." Journal of Sustainable Agriculture. 2(2):75-89.

LaFrance, Jeffrey. 1991. "Consumer Surplus vs. Compensating Variation Revisited." American Journal of Agricultural Economics. 73(5):1496-1507.

Lehman, Timothy S., Fred J. Hitzhusen, and Marvin Batte. 1995. "The Political Economy of Dredging to Offset Sediment Impacts on Water Quality in Ohio's State Park Lakes." Journal of Soil and Water Conservation. November-December 1995: 513-516.

Macgregor, D.R. 1988. "The Value of Lost Boater Value Use and the Cost of Dredging: Evaluating of Two Aspects of Sedimentation in Ohio's State Park Lakes." Unpublished Ph.D. Dissertation. The Ohio State University.

Macgregor, R., Judith A. Maxwell, and Fred J. Hitzhusen. 1991. "An Operational Model for Targeting Erosion Remediation on the Basis of Partial Off-Site Damage Assessments." Journal of Soil and Water Conservation. July-August, 1991: 301-304.

Rosen, Sherwin. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." Journal of Political Economy. 82(1):34-55.

The U.S. Soil Conservation Service and the U.S.Forest Service. 1990. "Impact of Nonpoint Pollution on Lakes in Ohio." August, 1990.